

# Utilising climate research to inform the insurance industry: can we dynamically simulate tropical cyclones for risk assessment?

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**Willis**





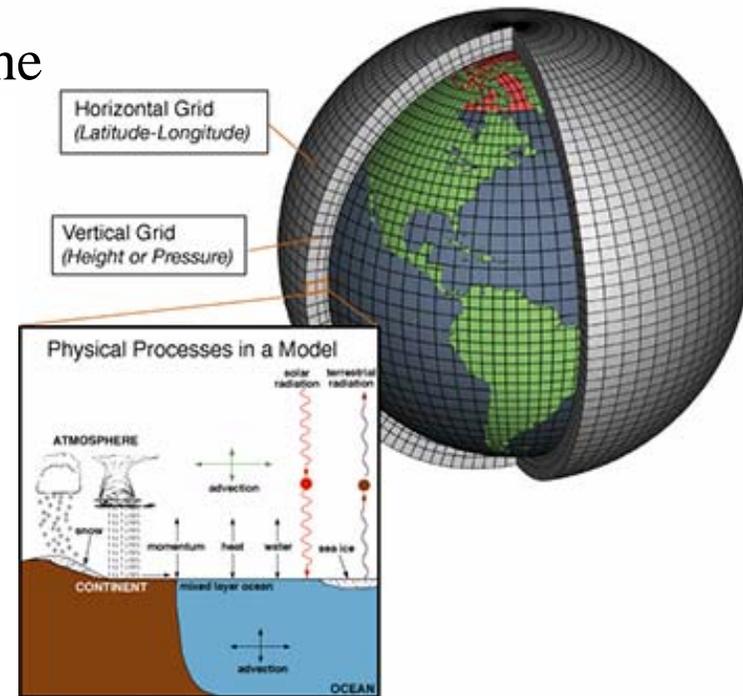
- A **major long term partnership** between leading international scientific institutions and Willis – a leading reinsurance broker.
- To undertake research into the **frequency, severity and impact of catastrophes**, such as hurricanes, earthquakes, extra-tropical windstorm and floods.
- Coordinated by Willis Analytics - who focus research and activities of the network towards the **needs of its clients and the international insurance and reinsurance market**.
- To encourage **focused, multi-disciplinary research**.



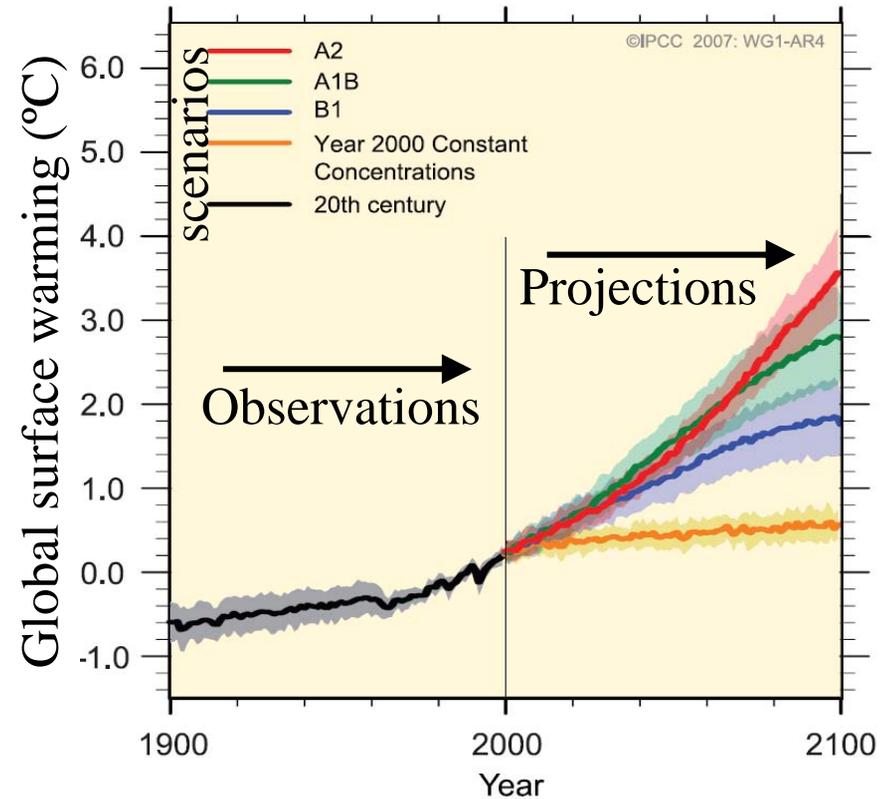
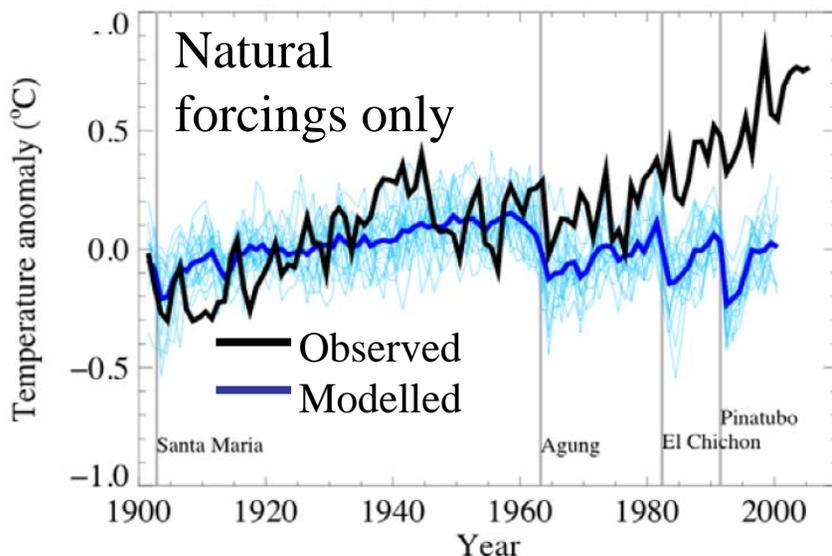
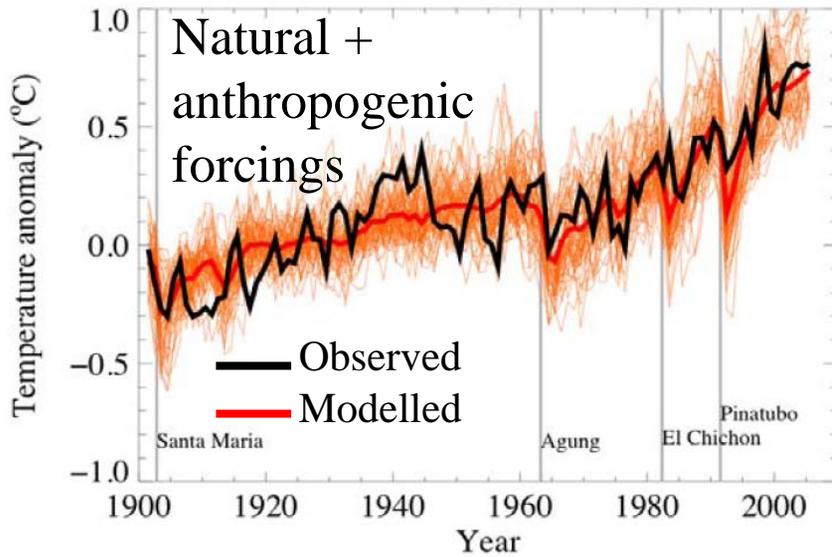
- How is global warming influencing the climate system?
- How are these changes affecting the severity, frequency and location of extreme events, such as tropical cyclones?
- Can we reflect climate change in climate catastrophe risk models?
- Can we reflect natural variability of the climate system in climate catastrophe risk models?
- Can we use dynamical models of the global climate system to influence climate catastrophe risk models?

# Dynamical Models of the Global Climate System

- Physically-based, dynamical models of the global climate system
- Based on fundamental equations of :
  - Motion
  - Thermodynamics
  - Radiative transfer
- These equations govern:
  - Flow of atmosphere and oceans
  - Exchange of heat between earth's surface & atmosphere
  - Release of latent heat energy by condensation during cloud & precipitation formation
  - Absorption/emission of solar/thermal radiation
- On a 3D grid of the earth's atmosphere & oceans



# Simulation of past and future climate



- The impact of **changes in atmospheric CO2 concentrations** on the climate system
- **Natural climate variability**: e.g. NAO, ENSO, decadal variability
- How natural climate circulation systems can lead to **teleconnection patterns**, linking climate related events and leading to **accumulation of seemingly unrelated risk**
- How the **frequency, intensity and location of extreme events** may change with:
  - (a) natural climate variability
  - (b) CO2 induced climate change
- The relationship between **small-scale extreme events** and the **large-scale global climate system**
- The possibility of **abrupt change** – and **irreversible change**

## End-user driven research

Temporal and spatial viewpoint

Variables of importance

## Reliance on historical data

Quality of data (coverage, consistency, detection and attribution)

Length of historical data (sample size)

## Non-independence of events – accumulation of risk

Teleconnections - impact of ENSO, NAO etc.

Clustering of events (e.g. wind storms)

## Dynamical nature of the climate

Climate change

Natural climate variability

## Complexity of extreme events

Interactions with the large-scale global climate system

Understanding complex processes- e.g. tropical cyclones

## Treatment of uncertainty

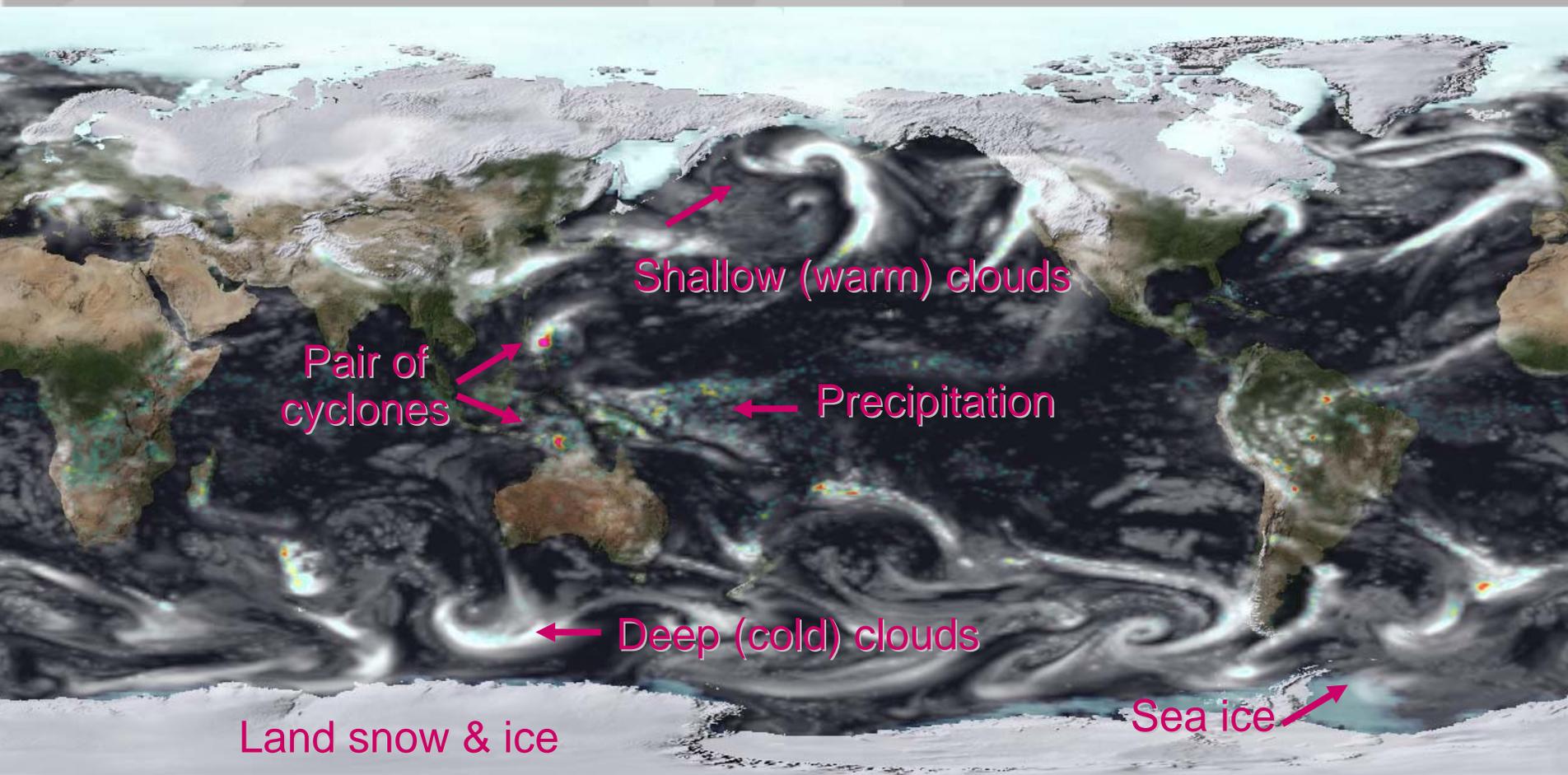
# Can dynamical models simulate tropical cyclones?



## Tropical cyclones:

- relatively small-scale features
  - complex physical structures
  - require very high resolution to be resolved properly
  - the IPCC states higher than 100km resolution is required
- Most Global Dynamical Models used for long (e.g. IPCC) integrations, cannot represent tropical cyclones properly.
  - It is important to study tropical cyclone activity in a global context. Tropical cyclone activity has very important relationships with the large-scale climate conditions.

# Can dynamical models simulate tropical cyclones?



**NUGAM high resolution model global simulation snapshot**

visualisation produced by NASA Earth Observatory

日英気候共同研究

UK-Japan Climate Collaboration

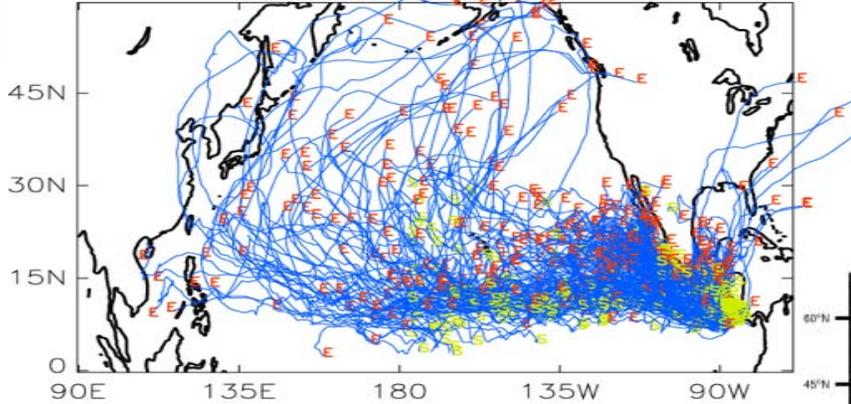


**National Centre for  
Atmospheric Science**  
NATURAL ENVIRONMENT RESEARCH COUNCIL

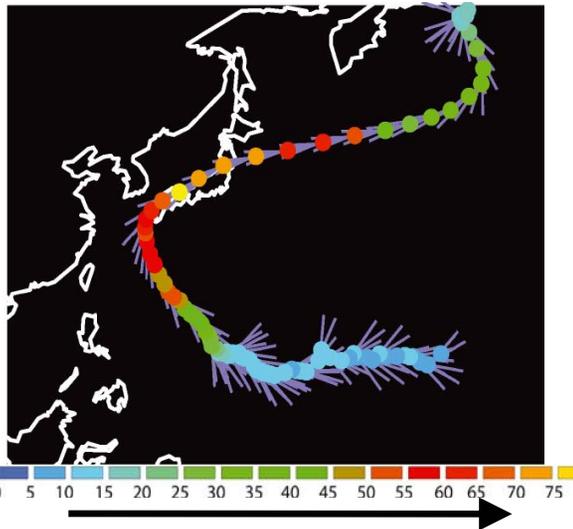


# Tropical cyclone tracking

NUGAM\_eafwa nepac tracks

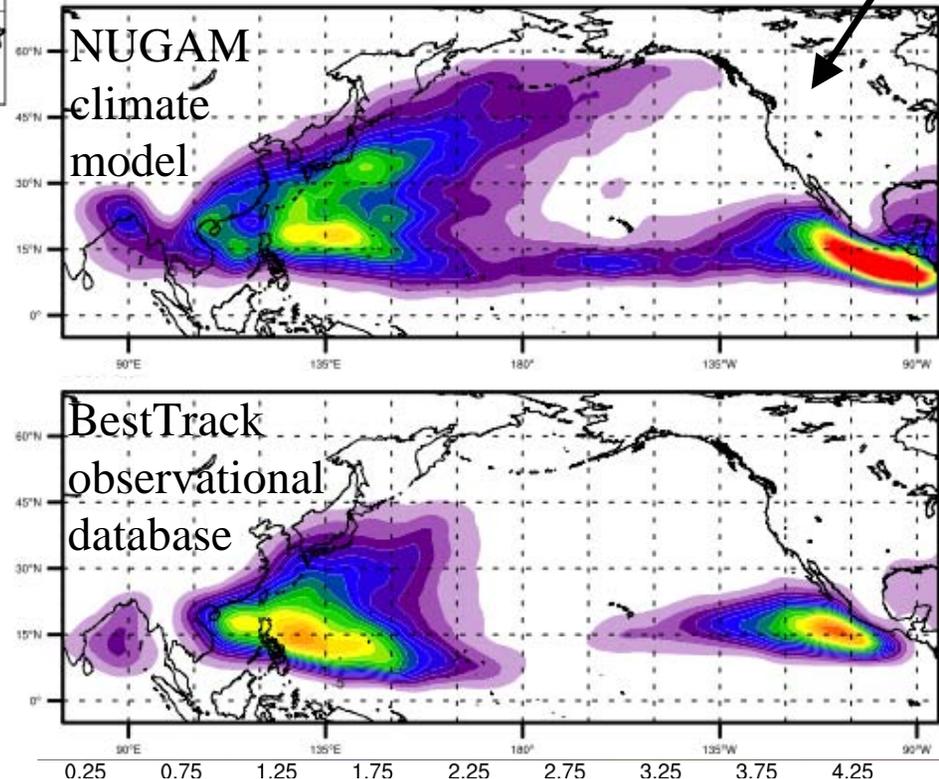


Track Density analysis  
Composite of the 100 most intense storms over 25 years of simulations



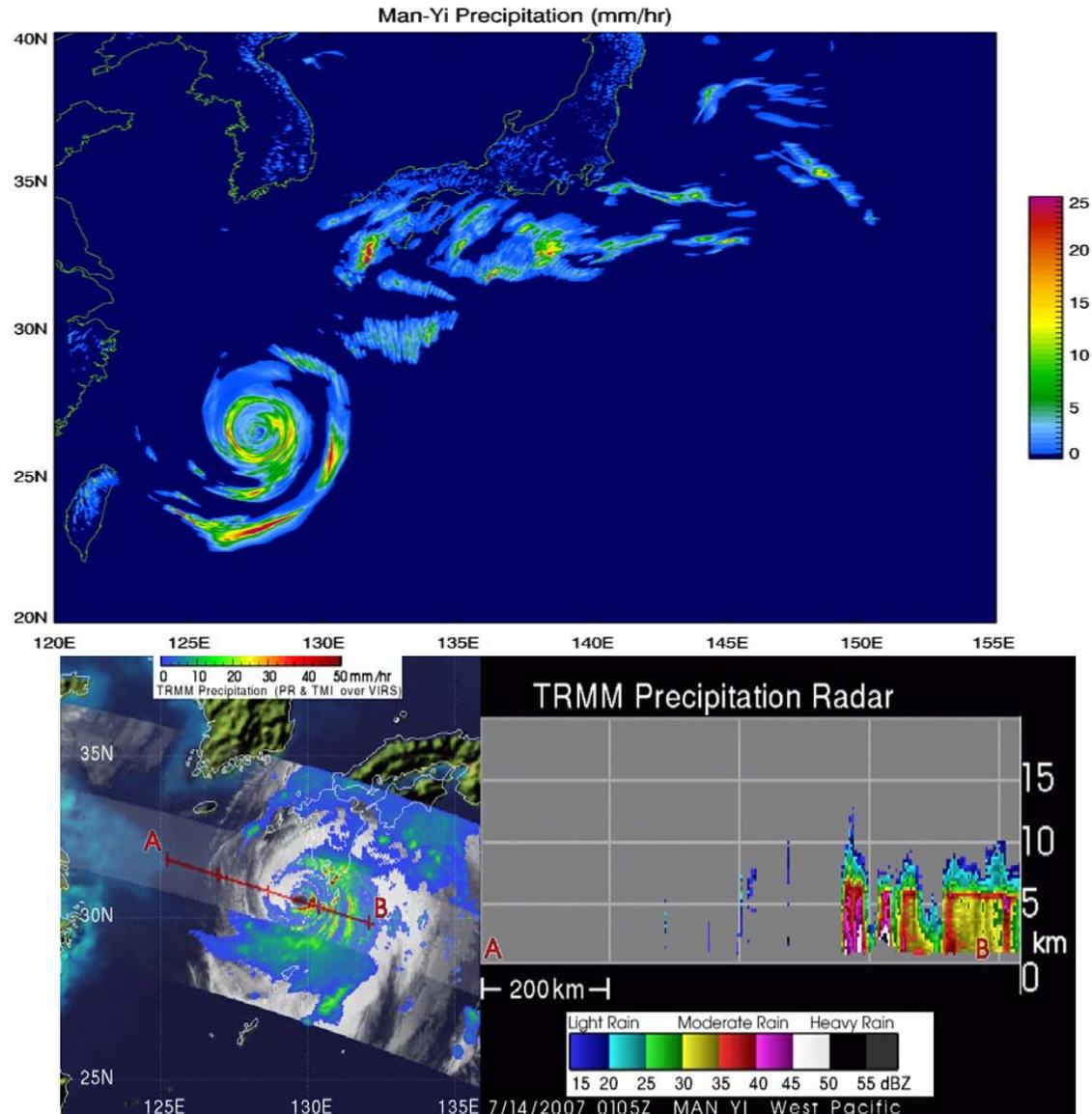
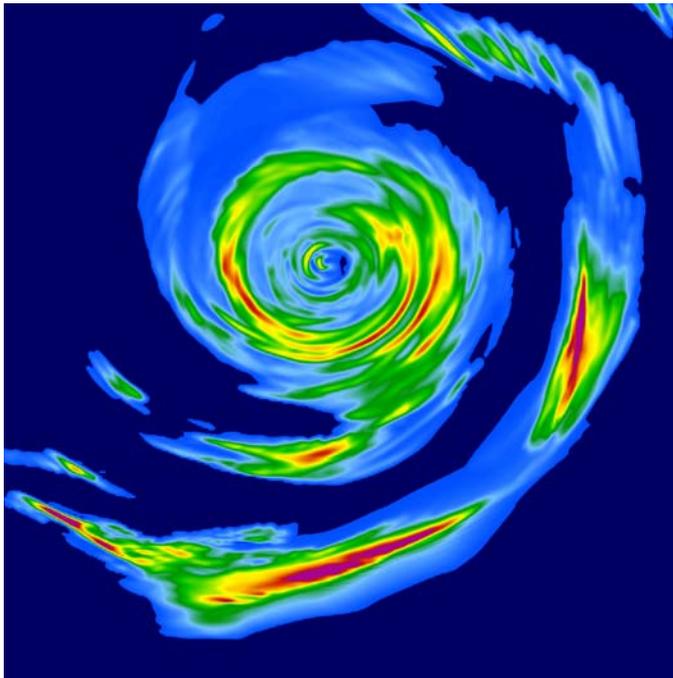
Storm intensity (vorticity)

Bengtsson, Hodges, Esch (Tellus,2007)



# Tropical cyclone simulation- Man-yi July 2007

Earth Simulator research group  
Multi-scale Simulator for the  
Geo-environment (MSSG)  
Maximum global resolution  
1.9km



- The Willis Research Network highlights the **opportunity for academic-industrial partnerships**:
  - **share data & expertise**
  - **influence and focus research**
- The WRN is working with advanced global climate models to assess **extreme weather events in a global climate context**
- This work has **huge implications for the risk assessment** in terms of understanding how risk may change under a both **anthropogenic and natural climate change**
- We are exploring the use **dynamical climate model simulations** to create artificial event-sets for hurricane/typhoon catastrophe models. This approach would **revolutionise the risk assessment of climate catastrophe**